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Effect of Wood Chips as a Component of Soilless Media on Growth and Nutrition of Food and Ornamental Crops

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EFFECT OF WOOD CHIPS AS A COMPONENT OF SOILLESS MEDIA ON GROWTH AND NUTRITION OF FOOD AND ORNAMENTAL CROPS

by

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ABSTRACT

Peat is the central component of the soil-less media mix in all greenhouse crop production but it is expensive because it is harvested in Canada and shipped to greenhouses across North America. Wood chips provide a local, low-cost alternative to peat, but observations by growers indicate potential growth reductions from the addition of wood to peat-based media. Here I report the effects of the addition of wood chips to peat-based media. The study included four treatments: two controls (peat/vermiculite: 50/50 and 75/25) and two treatments with wood chips (peat/wood chips: 50/50 and 75/25) with three species (sunflowers, soybeans, and cucumbers) in each treatment. All containers were maintained in identical conditions on a greenhouse bench with supplemental light. At harvest on day 26, dry mass, fresh mass, and leaf area were measured and comparative photographs were taken. There was no statistically significant difference between the 25% and 50% treatments, with either the wood or the vermiculite, but both the wood chip treatments reduced growth of all three species. Fresh mass with wood chips in sunflowers was 52% of the control, the cucumbers were 31% of the controls, and the soybeans were 74% of the control. The detrimental effect of wood chips appears to vary with species.

ACKNOWLEDGEMENTS

I would like to thank Dr. Bruce Bugbee and Alec Hay for contributing to this project with materials, advice, and support. I would also like to thank Will Wheeler, Jakob Johnson, and Terri Manwaring for their help and support. Lastly, I would like to thank the College of Agriculture and Applied Sciences and the Plant Soils, and Climates Department for the help they have given.

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INTRODUCTION

Wood chips have been used controversially as a soil additive for many years. There have been several studies exploring the potential of wood chips to be used as a cheaper alternative for more expensive additives like vermiculite and perlite. (Braddy, et al, 2017; Scharenbroch, and Watson, 2014) Vermiculite is used to add aeration and water retention to a soilless mixture; sometimes it is used exclusively to germinate seedlings. (Grant, n.d.) There is a substantial price difference between them, wood chips cost around $0.5/ft^3, while vermiculite costs around $6-$8/ft^3. (Greenhouse megastore, 2018) Depending on the crop this can make a huge difference in initial costs and profits. The wood chips can potentially increase water retention and increase nutrient uptake. (Fields, et al, 2014; Johnson, J. et al, 2017) There has been some research done on the side effects of adding wood chips to growing media, but it has not been tested on a wide variety of crop species.

MATERIALS AND METHODS

To compare the influence of potting mixes based on wood chips or vermiculite and their effect on the growth of different plant species, greenhouse experiments were initiated in September of 2017. Soilless media was made containing differing levels of wood chips or vermiculite as listed in Table 1.

Table 1: The total amount of components added to the soilless mix for the trials. These are standard ratios for commercial mixtures. (Boodly, J.W., and Sheldrake R., Jr., n.d.)

Treatment	Peat	Wood Chips/ Vermiculite	Lime	Gypsum
PV 50/50	6 L	6 L	0	1 g/L
PV 75/25	9 L	3 L	2 g/L	1 g/L
PW 50/50	6 L	6 L	4 g/L	1 g/L
PW 75/25	9 L	3 L	4 g/L	1 g/L

To make each treatment the peat, wood chips or vermiculite, lime, and gypsum were mixed in a large container. For example, with the PV 50/50, 6 L of peat and 6 L of vermiculite were mixed with 1 g/L (or 12 g) of gypsum. The mixture was then divided between the twelve 1.5 L pots and labeled. This process was repeated for each of the different treatments.

The species tested included soybean (Hoyt), cucumber (Straight Eight), and sunflower (Teddy Bear). Treatments were established by planting four seeds of each species 0.25 inches deep into each respective soil media. Each species by soil media combination were replicated three times. Pots were placed in the greenhouse where they grew for four weeks. They were heavily watered for the first week, then watered about every three days with nutrient solution until the end of the trial. During week three, the plants were thinned from four plants per pot to one plant per pot. Once a week the EC and pH of the leachate was measured for each specimen. Then after four weeks the plants were photographed and harvested.

Several tests were performed on the plants. The leaf area and the stem, leaf, and total fresh mass of each plant was then measured and recorded. Then they were put into labeled bags and into the oven for one week. After they were sufficiently dried, the stem, leaf, and total dry mass of each plant was measured and recorded. After all the data was collected, statistical tests were run. The tests that were run for this experiment were an ANOVA test and a Tukey-HSD test.

RESULTS AND DISCUSSION

The appearances and overall health of the plants differed throughout the different trials. There were varying degrees of differences, with cucumbers exhibiting the greatest difference (see figure 2), then sunflowers (see figure 3), then the soybeans exhibiting the smallest difference among treatments (see figure 1).

Figure 1: Soybean trial comparison; there is little difference between each trial, indicating that there was no difference between the peat with wood chips or vermiculite.

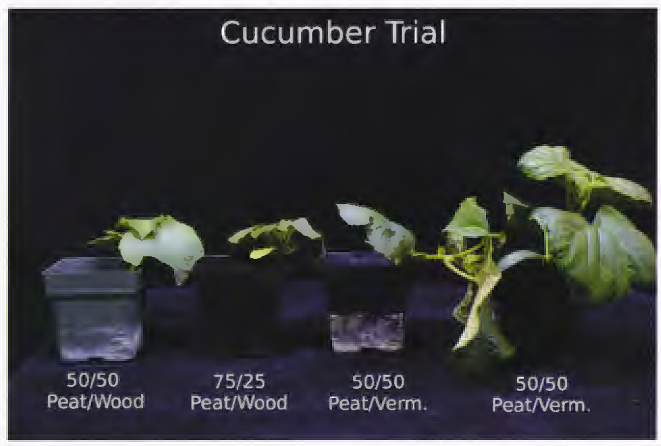

Figure 2: Cucumber trial comparison; there is a noticeable difference between each trial, indicating that there was a significant difference between the peat with wood chips or vermiculite.

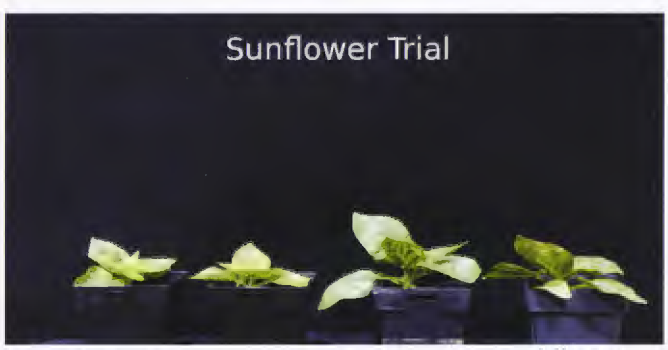

Figure 3: Sunflower comparison there is a noticeable difference among treatments, indicating that there was a significant difference between the peat with wood chips or vermiculite.

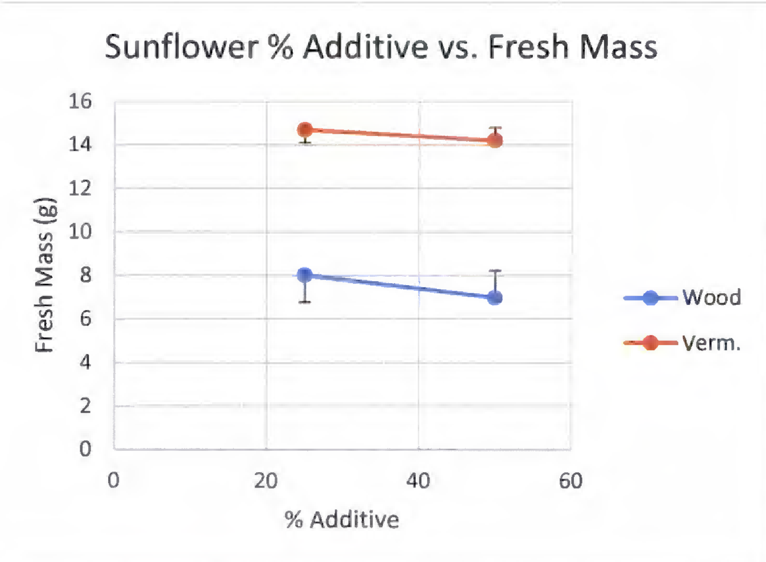

Figure 4: *Response of sunflower fresh biomass to percent addition of wood chips or vermiculite to soilless media.*

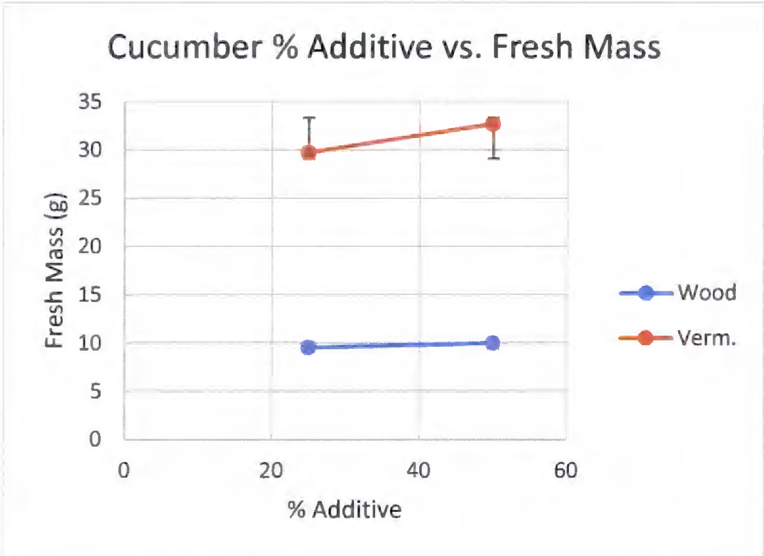

Figure 5: The response of cucumber fresh biomass to percent addition of wood chips or vermiculite to soilless media.

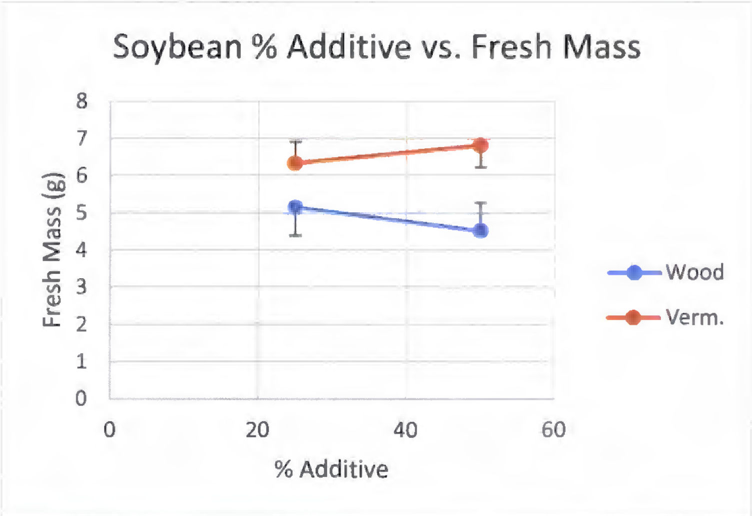

Figure 6: The response of soybean fresh biomass to percent addition of wood chips or vermiculite to soilless media.

The fresh mass for the sunflowers (see figure 4) and the cucumbers (see figure 5) were both statistically different, while the fresh mass of the soybeans (see figure 6) were not. This indicates that there was something inhibiting the growth of the ones with woodchips in the sunflowers and cucumbers, but not the soybeans.

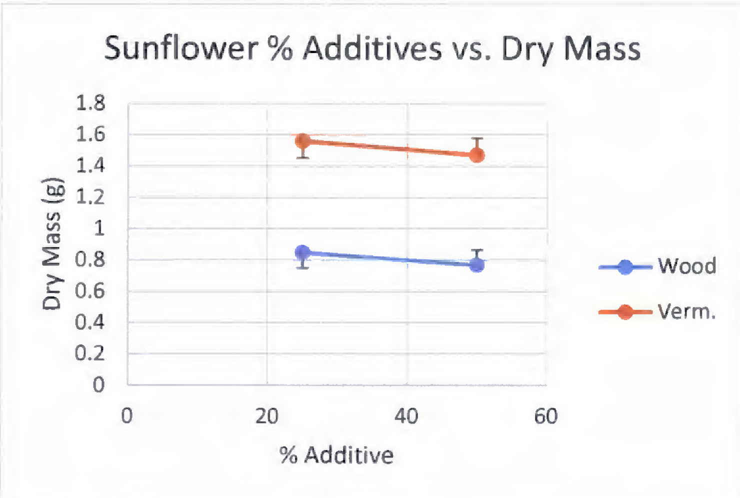

Figure 7: The percent additive vs. dry mass. As you can see, the controls had much more mass than the ones that contained wood chips.

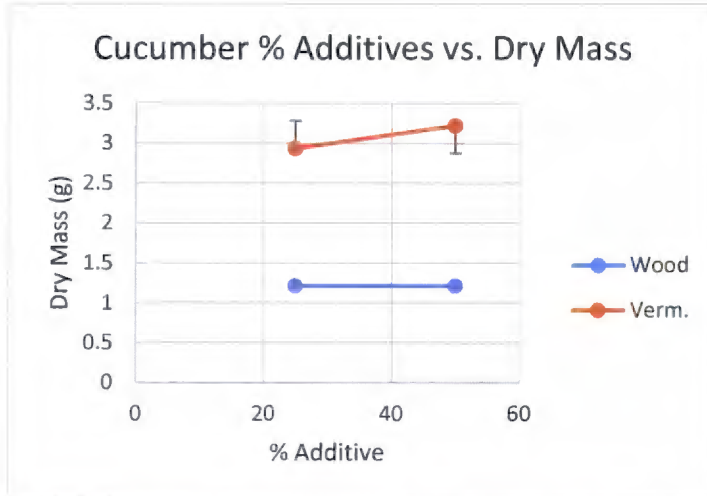

Figure 8: The percent additive vs. dry mass. As you can see, the controls had much more mass than the ones that contained wood chips.

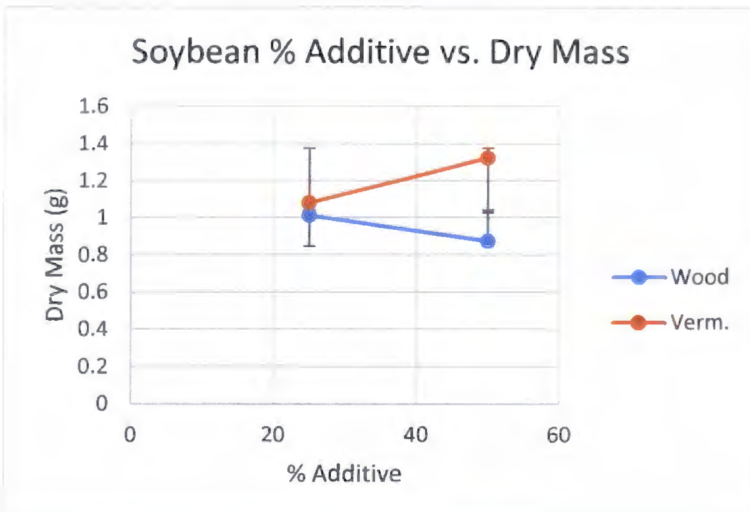

Figure 9: The percent additive vs. dry mass. The masses were extremely similar, showing that there was little difference between the wood chips and the controls.

The dry mass of the controls overall had higher masses than the wood chip treatments did (see figure 7 and 8). The only difference was that they soybeans had a very small difference, one that was not statistically significant (see figure 9).

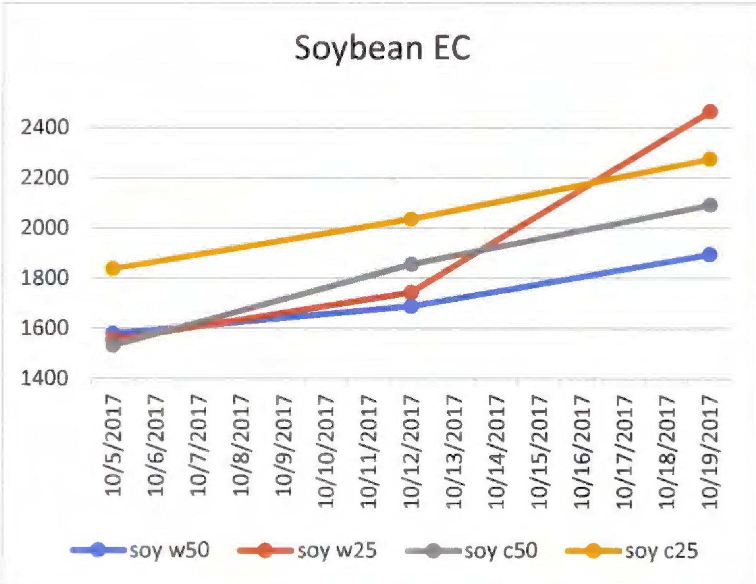

Figure 10: Response of measured EC of leachate from pots growing soybeans under different soilless media containing either wood chips or vermiculite.

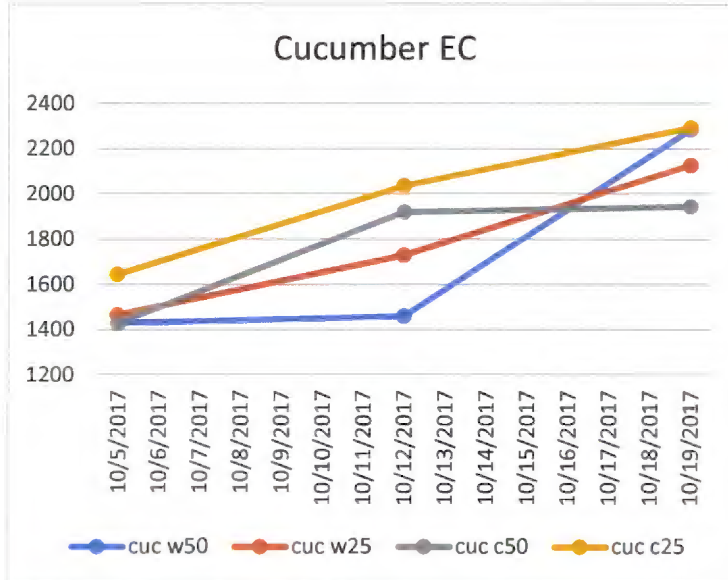

Figure 11: Response of measured EC of leachate from pots growing cucumbers under different soilless media containing either wood chips or vermiculite.

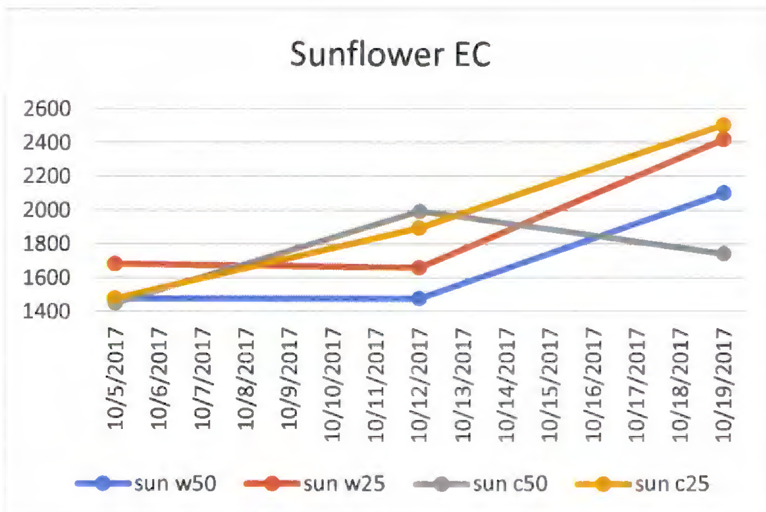

Figure 12: Response of measured EC of leachate from pots growing sunflowers under different soilless media containing either wood chips or vermiculite.

In figure 10, all the trials follow the same trend, but the PW 75/25 spiked between the second and third weeks, which is different from the other trials. In figure 11, almost all the trials follow the same trend, except the two control groups. They started to decrease while the PW mixes increased. In figure 12, all but the PV 50/50 followed the same trend. It decreased while the other trials increased. The EC (Electrical Conductivity) measures the amount of salts, nutrients, or other impurities in the water or solution being tested. (getbluelab, 2014) Since this trial was only 4 weeks long, there are few data points to explore, which makes it hard to extrapolate and see what caused the interesting spikes and dips.

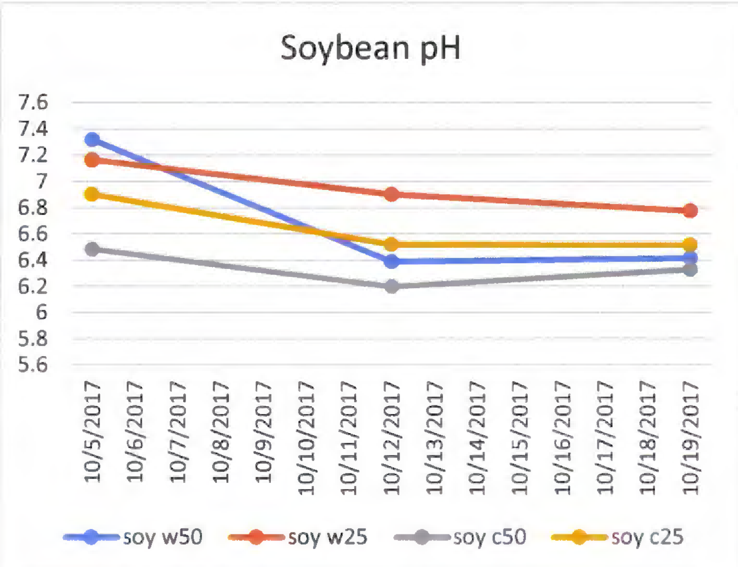

Figure 13: Response of measured pH from leachate of the pots growing soybeans under different growing conditions of wood chips (w25, w50) or vermiculite (c25, c50).

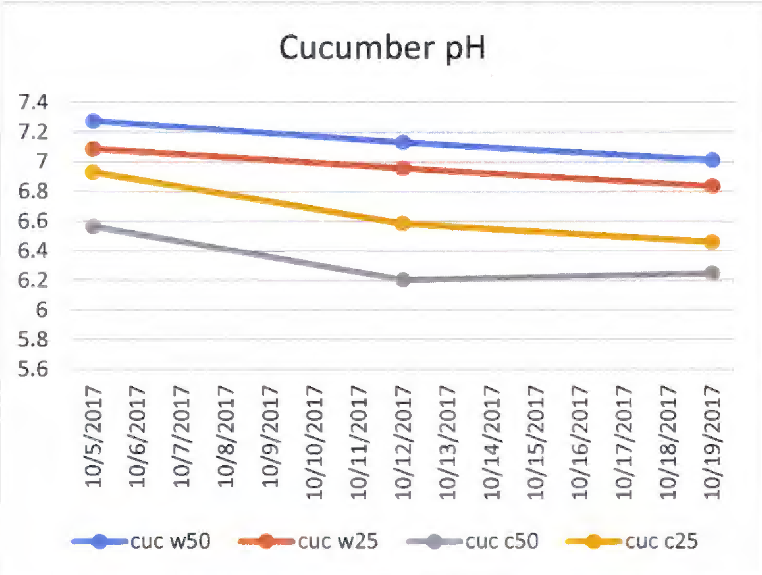

Figure 14: Response of measured pH from leachate of the pots growing cucumbers under different growing conditions of wood chips (w25, w50) or vermiculite (c25, c50).

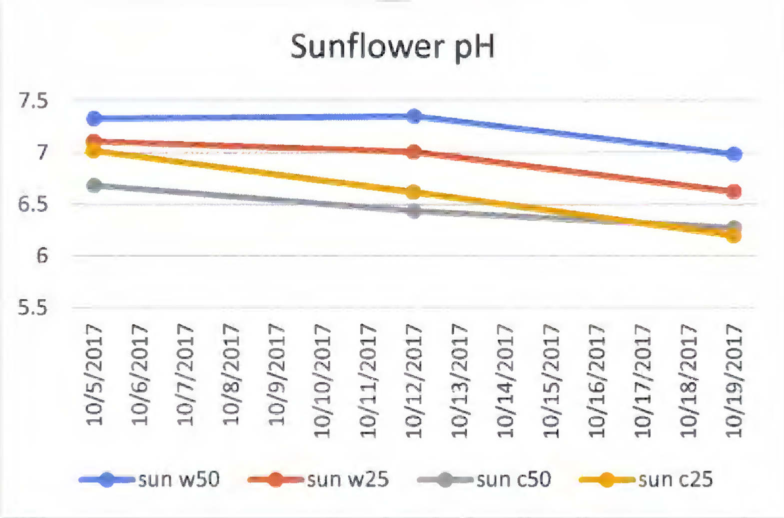

Figure 15: Response of measured pH from leachate of the pots growing sunflowers under different growing conditions of wood chips (w25, w50) or vermiculite (c25, c50).

The ideal pH for most plants is in the 5.5-7 range (Perry, L. 2003), and this data shows that all the trials were in that range by the end of the experiment. Each of the different treatments got there differently, for example some started out higher than others (see figure 15), but they all eventually ended up in the same range, which is ideal for growing most plants, especially in a greenhouse.

Overall, between the three trials, there were three different results. For the soybeans, there was no difference between the wood treatments and the control treatments in the majority of the tests we conducted. The sunflowers had a small but still significant difference between the wood and control treatments. Lastly, the cucumbers had a large significant difference between the wood and control treatments. We believe the difference in these differences is due to the plant's ability to handle the wood chips. The biggest indication of wood chip harm was from the fresh and dry mass data. There were huge differences between the wood and control groups in the cucumbers especially. This shows that the wood chips were having a detrimental effect on the growth of these plants. This trend was repeated in the sunflower trials, but on a smaller scale.

The statistical analysis showed that the percentage of wood or vermiculite didn't really affect the growth rate of the plants, but that there was a significant difference between the wood treatments and the control treatments. The amount of wood or vermiculite wasn't a key factor, it was the fact that the growing media had wood chips in it that caused some of the plants to be stunted and show slower growth rates.

The statistical data showed that there was a significant difference in plant mass across all the species between the treatments of wood and the control treatments. However, there was not a significant difference between the 50% control treatments and the 25% control treatments, and the 50% wood and 25% wood treatments across all species.

CONCLUSIONS

From this experiment, we can conclude that the addition of wood chips affects different species in different ways. For soybeans, it doesn't benefit or damage the crops, while for cucumbers it could have larger impacts on yields and health of the crop. When wood chips were added to the peat mix instead of vermiculite it stunted the cucumbers and sunflowers in both the 50/50 and 75/25 peat/wood mixes.

REFLECTIVE WRITING

This project has opened so many doors for me and for my future career. One of the most important aspects of this career field of plant science is to create and carry out experiments from start to finish. It has taught me what it will be like to work in this career field, and I have learned several valuable skills that I wouldn't have learned otherwise.

When I started this project, there were four different species I was testing, they included: zucchini, soybeans, sunflowers, and cucumbers. After the third week, the zucchini hadn't germinated properly and all the data had to be thrown out for that species. It was hard to lose all that data, but it was necessary to complete the experiment and keep it valid. Even though I was unable to use the zucchini data, I could use the other three species data, which provided enough detail to complete the experiment and interpret valid results.

This experiment added to my overall education by teaching me to problem solve in short-time periods, write a scientifically correct research paper, and allowing me to work with plants and the tools that involves. I ran into a few problems along the way with timing and germination rates, so I had to make some tough decisions about my data and scheduling conflicts. I had to take that data that I had collected and turn it into an understandable, interesting, and well-put research paper. I also had to learn how to use tools like an EC meter, pH meter, and the dry mass blender. These are all necessary skills to allow me to be successful in a future career in plant research.

This project allowed me to learn crucial skills from my mentor in a positive and encouraging way. It was extremely valuable to have an opportunity to approach my mentor and learn some of the skills he's acquired while working in the field. The biggest skill that was learned from my mentor was how to read a graph and interpret it. This is an extremely valuable skill to have, especially in the field of plant science where graphs are made and interpreted all the time. Because of this project I was given the opportunity approach my mentor and talk to him about my graphs and use them to get to a conclusion about the data.

My research experience deepened my education and passion for plant research. Throughout the entire project, I found myself enjoying taking measurements like pH and EC, which helped deepen my passion for this career field. It was valuable to see if I would even like doing research like this because now I know for certain that I can and will be a plant researcher.

Topics like soilless media additives are big in the plant science field, so it was beneficial to do research that will add to that knowledge bank. People are always looking to find new, cheaper ways of growing food qualitatively and quantitatively. This kind of research has the potential to contribute to that, and it is amazing to think of all the people that my research could help.

This project allowed me to broaden my overall experience in many ways other than just completing more research. I was also able to write a paper, which required knowing and using proper scientific language that would contribute to the readability of the paper. Another aspect of this experiment was using calculations to find the proper amounts of growing media, additives, and compare the tests. Lastly, the calculations had to be interpreted so that they could be compared accurately.

The goal of this experiment is that people will read my research before they add wood chips to their growing substrate. The wood chips did not hinder the soybean growth rates, but it also didn't give them a significant advantage either. Depending on the crop, the wisest course of action would be to do some research on the different soil additives and make an educated decision based on the farmer's soil, crop, and location.

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PROFESSIONAL AUTHOR BIO

Kristen Bullough is a senior in Plant Science with an emphasis in research at Utah State University with a minor in crop biotechnology. In Fall of 2017 she was awarded the Wade G. Dewey Utah-Idaho Grain Exchange Scholarship. She has been involved in research at the USU Crop Physiology Lab and at the USDA Pollinators Lab, and she is excited to continue working in the lab. She plans to graduate in May 2018 and plans to work until graduate school becomes a possibility for her. Her future goal is to work in the plant pathology field.